



Climate-in-a-Box Workshop: WRF Tutorial



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Outline

- WRF Description
- WRF Setup
- WPS Architecture
 - WPS Executables
- WRFV3 Architecture
 - WRFV3 Executables
- Compiling WPS and WRFV3
- Running WPS and WRFV3
- Visualization
- WRF Case Study



WRF Description

- WRF – Weather Research and Forecasting Model
 - Research and Operational Applications
 - Regional Applications
 - Fully compressible, non-hydrostatic
 - Mass based terrain following coordinate system, η
 - Staggered Arakawa C-grid
- Contains options for Chemistry, Data Assimilation, Fire modeling, etc...
 - For the purposes of this tutorial, we are only building the standard WRF package

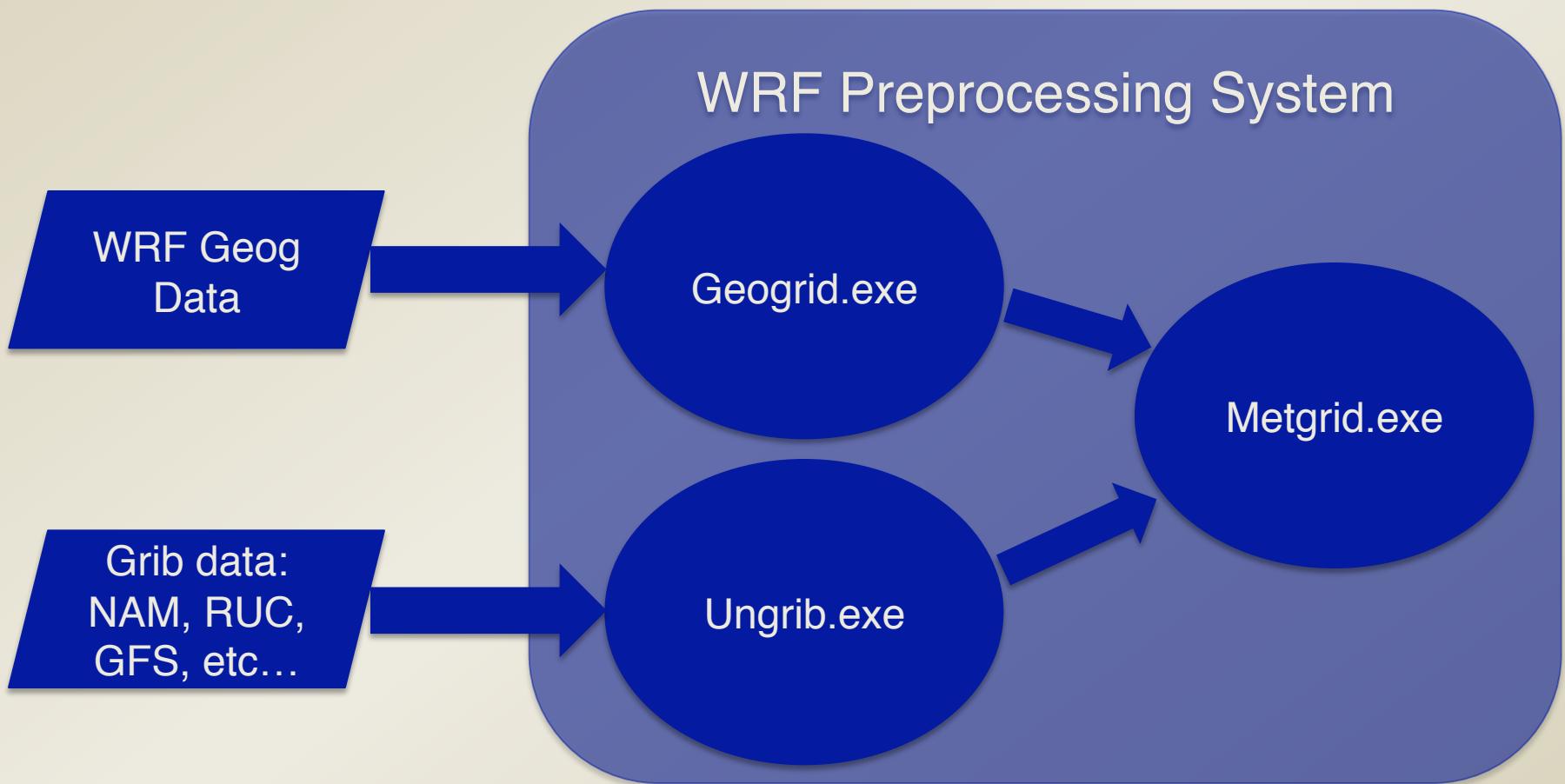


WRF Setup

- WPS – WRF Preprocessing System
 - Prepares input data into WRF for real-data simulations
 - Defines the domain area
 - Produces static fields such as terrain, land use, soil types, etc...
 - Interpolates the meteorological initialization data onto the WRF grid (horizontally)
- WRF model
 - Sets up vertical model levels
 - Numerically integrates the model



WPS Architecture



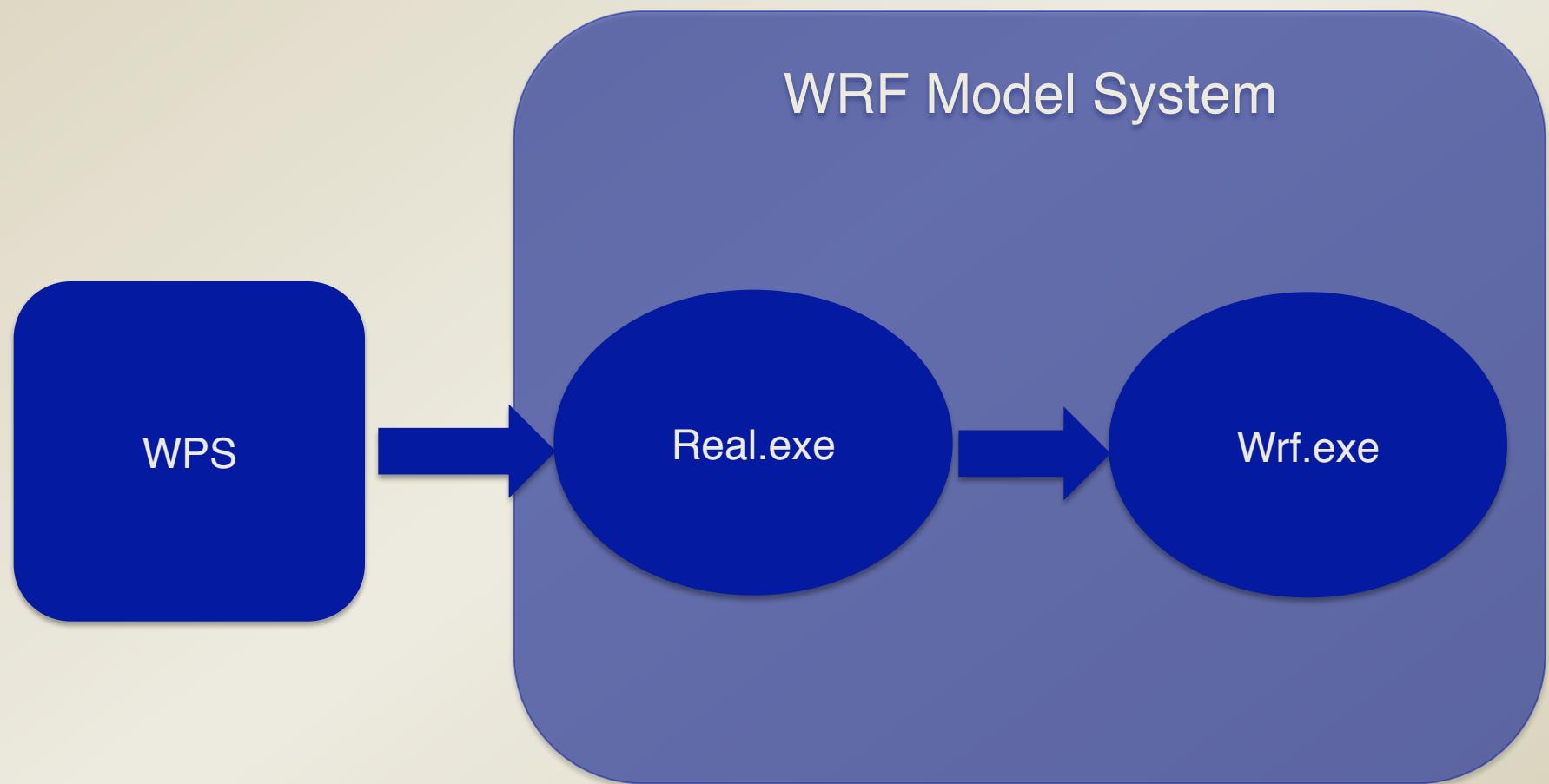


WPS Executables

- **Geogrid.exe**
 - Defines the map projection, geographic location and dimensions of the domains
 - Provides static field information for terrestrial data
- **Ungrib.exe**
 - Read GRIB1 and GRIB2 formats (Gridded Binary Data)
 - Extracts met fields
 - Writes fields to intermediate format
- **Metgrid.exe**
 - Horizontally interpolates the met data to WRF grids



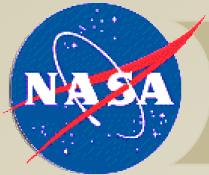
WRF Model Architecture





WRF Executables

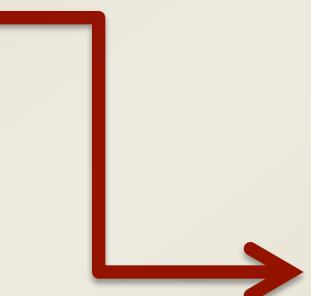
- **Real.exe**
 - Vertically interpolates met fields to model levels
 - Creates initial and boundary conditions files for real-data cases
- **Wrf.exe**
 - Runs the WRF model simulation
 - Numerically integrates the model simulation
 - Outputs history and restart files



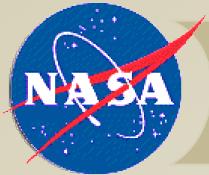
WRF Prerequisites

- Netcdf

- Libpng
- Zlib
- Jasper
- Ncl



Required to use
GRIB2 format data



Compiling WRF

- WRFV3 must be compiled before WPS
- Steps to compiling WRFV3
 - 1. Copy over the WRFV3 tarball
 - cp /cib/models/archives/WRFV3.1.TAR.gz .
 - 2. Untar the WRFV3 tar file
 - tar xvfz WRFV3.1.TAR.gz
 - 3. Move to WRFV3 directory
 - 4. Configure the model
 - ./configure
 - Choose option 7 (Linux x86_64 i486 i586 i686, ifort compiler with icc (dmpar))
 - Choose option 1 for nesting



Compiling WRF cont...

- Steps to compiling WRFV3
 - 5. ./compile em_real >& compile.log & (for csh)
./compile em_real &> compile.log & (for bash)
- Executables generated:
 - main/real.exe
 - main/wrf.exe
 - main/nup.exe
 - main/ndown.exe (does one-way nesting)



Compiling WPS

- WPS must be located on top level directory
(along with WRFV3)
- Steps to compiling WPS
 - 1. Copy over the WPS tarball
 - cp /cib/models/archives/WPSV3.1.TAR.gz .
 - 2. Untar the WPS tar file
 - tar xvfz WPSV3.1.TAR.gz
 - 3. Move into the WPS directory
 - 4. Configure WPS
 - ./configure
 - Choose option 4 (PC Linux x86_64, Intel compiler)



Compiling WPS cont...

- Steps to compiling WPS

- 5. Edit the configure.wps file
 - Replace -L/usr/X11R6/lib with -L/usr/X11R6/lib64
 - Change the COMPRESSION_LIBS and COMPRESSION_INC paths
 - 6. Compile WPS
 - ./compile >& compile.log & (for csh)
 - ./compile &> compile.log & (for bash)

- Executables generated:

- geogrid.exe
 - ungrid.exe
 - metgrid.exe



Running WPS

- Edit the namelist.wps
- Run geogrid.exe
 - ./geogrid.exe
 - Generates files: geo_em_dxx.nc
- Link the proper Vtable
 - In –sf ungrid/Variable_Tables/Vtable.GFS Vtable
- Link the input GRIB data
 - ./link_grib.csh path_to_GRIB_data
 - Generates links: GRIBFILE.AAA, GRIBFILE.AAB.
Etc...



Running WPS cont...

- Run ungrb.exe
 - `./ungrib.exe`
 - Generates Files: FILE:2010-02-05_00, ...
- Run metgrid.exe
 - `./metgrid.exe`
 - Generates Files: met_em.dxx.YYYY-MM-DD_HH:
00:00.nc



Running WRF Model

- Move into WRFV3 run directory
 - cd WRFV3/run
- Edit the namelist.input file
 - Make sure that the values match the namelist.wps
- Link the files produced by metgrid.exe to the run directory
 - ln -s ../../WPS/met_em* .
- Edit the run_real.job script
 - Make sure the path is correct



Running WRF Model cont...

- Submit run_real.job
 - qsub run_real.job
 - Files produced:
 - wrfinput_dxx
 - wrfbdy_d01
- Edit the run_wrf.job script
 - Make sure paths are correct
- Submit run_wrf.job
 - qsub run_wrf.job
 - Files produced:
 - wrfout_dxx.....



WRF Documentation

- Documentation on how to run/compile WRF can be found at:
 - The CIB User's Guide
 - <http://modelingguru.nasa.gov/>
 - WRF Model Users Website –
 - <http://www.mmm.ucar.edu/wrf/users>



Setup WRF Simulation

- Hurricane Earl – Sep 2nd, 2010
- First step: Retrieve data to initialize WRF Model
 - <http://nomads.ncdc.noaa.gov/>
 - Place data onto Nimbus
- Edit namelist.wps in WPS directory
- Use util/plotgrids.exe to examine domain configuration
- Edit namelist.input



WRF Case Study

- DC “Snowpocalypse” Event
 - February 5, 2010
 - Domain centered on Dulles International Airport (IAD)
 - 48 hour simulation
 - Triple Nested Domain
 - Horizontal Resolution 16, 4, 1 km
 - Horizontal Grid Size: (198x191), (301x285), (357x345)
 - 28 Vertical levels
 - Run with 48 cores



Run WRF Case Study

- Move to your outputdata location
- Copy over the WRF run directory into your output location:
- Change over to the run directory
- Workshop demo only runs single domain
- Edit/submit the run_wrf.job script
 - Executables already built
- Will produce wrfout files from Feb 5 00Z – 12Z



Summary of Steps to Run Case Study

- cd /cib/outputdata/guestX, where X = your number
- cp -R /cib/models/wrf/wrf3.1/Workshop_demo/run .
- cd run
- Edit path on line 10 of run_wrf.job (Change X to your number)
- qsub run_wrf.job
- To run “Full” Case study replace this command for step 2:
 - cp -R /cib/models/wrf/wrf3.1/Case_Study_demo/run .



Visualization

- NCL sample script

- plotVars.ncl

- Steps to run plotVars.ncl

- **Provide the file to be plotted**

```
f = addfile ("wrfout_d01_2010-02-07_00:00:00.nc", "r")
```

- **Provide the Variable to plot**

```
x = f -> QVAPOR
```

- **Provide the output file name**

```
wks = gsn_open_wks("ps", "Qvapor_plot")
```

- To run:

- ncl plotVars.ncl

- To view the image type:

- display Qvapor_plot.ps



Sample Output

